ІНІЦІАТИВА З ПИТАНЬ ЗМІНИ КЛІМАТУ
CLIMATE CHANGE INITIATIVE

DELIVERABLE № 6, 2000

Training Program

Module 4: GHG Emissions Inventory in Energy sector

Prepared for:
The United States Agency for International Development
under Contract LAG-I-00-98-00005-00, Task Order 16

Prepared by:
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September 2000
Updated September, 2002

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Module Contents

Overview

Session Plan	*Session type*	*Duration (minutes)*	*Materials*
Session 1:			
Emission sources and greenhouse gases	Lecture	10	Slides 2-3
CO_2 emissions and approaches in calculation	Lecture	20	Slides 4-7
IPCC Reference approach	Lecture	45	Slides 8-13
Approach "by emission sources"	Lecture	45	Slides 14-19
Emissions from mobile sources	Lecture	30	Slides 20-24
Emissions from burning biomass	Lecture	20	Slides 25-26
Emissions from coal sector	Lecture	30	Slides 27-30
Emissions from oil gas sector	Lecture	30	Slides 31 – 33
Example of GHG emissions calculation for Ukraine	Group Exercise	90	Example
Session 2: Inventory of GHG emissions in USA	Lecture	60	16 Slides
Session 3: Inventory of GHG emissions in Ukraine	Lecture	15	18 Slides
Session 4: Emissions from the power sector of Ukraine	Lecture	30	27 Slides
Session 5: Inventory of the GHG emissions from the coal sector of Ukraine	Lecture	45	15 Slides

Background

Module 4 presents the methodology to calculate greenhouse gas (GHG) emissions, including those of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), which occur from the energy sector. Fossil fuel and biomass combustion and the oil and gas sector are viewed as major emission sources.

Participants

Module 4 in intended for experts in global climate change dealing with greenhouse gas emissions inventory. Participants from regulatory authorities, research and development institutions, educational establishments will also benefit.

Objectives

This module aims to impart an understanding of the inventory of GHG emissions from the energy sector. It is expected that the participants will also get familiar with the IPCC Inventory Guidelines.

Module Basics (Streamlined Version)

- ***Duration***: 2 days
- ***Participants:*** 20-30
- ***Venue:*** Kiev
- ***Facilities (recommended):*** The module can be presented in any comfortable training facility. Adequate space for plenary presentations should be made available.
- ***Format:*** Workshop; first day includes one session and a practical exercise; the second day consists of four sessions; each day is concluded with a discussion session.
- ***Instructors:*** 2 or 3 Ukrainian experts and 1 international expert
- ***Audio/Visual Needs:*** Overhead projector, overhead monitor, whiteboard
- ***Contacts:*** Natalya Parasyuk of CCI ; Alexei Sankovskiy, ICF Consulting, 1850 K-street, NW, Washington, DC 20006, tel. 202-862-1137, fax. 202-862-1144, e-mail: asankovski@icfconsulting.com.

Reading and Resources: Citations for a number of key reports are included for further reference on the subject of inventory of GHG emissions.

Participant Materials: This material consists of a series of handouts. Only one copy of each of the handouts is included in the workshop package. Copies of the handouts should be made prior to the workshop. The presenter may wish to

ask someone to help distribute handouts to save time. Presenters are encouraged to make certain that enough copies of the handouts have been prepared, and to arrange the handouts so that they can be distributed with ease during the workshop.

Overhead transparencies: OHTs for selected sessions are included at the end of this training package. Each of these OHTs is numbered consecutively and has titles based on their content. The organizer of future offerings of Module Four should include the up-to-date presentations of other countries' experience to make the Module meet demands of the region.

Evaluation Process

Module Four should be evaluated in order to improve the workshop package for more effective subsequent use. The evaluation can be conducted using a simple questionnaire, which can be found at the end of this package. At the close of the second day, the organizer should ask the participants to take five to ten minutes to complete the evaluation form. Participants should be asked to put down their names on the forms.

Agenda

Below is the recommended agenda for Module 4.

Suggested Agenda

Inventory of GHG Emissions for "Energy" Sector

Day 1: Basic methods of GHG emissions inventory

9.00 – 9.30	Registration of participants
9.30 – 9.50	Opening remarks
9.50 – 10.20	**Emission sources and greenhouse gases** **CO_2 emissions and approaches to their calculation**
10.20 – 10.30	Discussion
10.30 – 11.00	**Reference approach of IPCC**
11.00 – 11.15	Discussion
11.15 – 12.00	**Approach by emission sources**
12.00 – 12.30	Discussion
12.30 – 13.30	**Lunch**
13.30 – 14.00	**Emissions from mobile sources**
14.00 – 14.15	Discussion
14.15 – 15.00	**Emissions from biomass burning**
15.00 – 15.50	**GHG emissions in coal industry** **GHG emissions in oil and gas industry**
15.50 – 16.20	Discussion
16.20 – 17.50	**Group practical training** **Calculation of GHG emissions on the example of Ukraine**
17.50 – 18.00	Summary of Day 1

Day 2: Experience in GHG emissions inventory

9.00 – 9.30	Review of the Day
9.30 – 10.30	**Inventory of GHG emissions in USA: best practice**
10.30 – 11.00	Discussion
11.00 – 11.45	**GHG Inventory in Ukraine;** **Emissions from the power sector**
11.45 – 12.15	Discussion
12.15 – 12.45	Break
12.45 – 13.30	**GHG inventory in the coal sector of Ukraine**
13.30 – 14.30	Panel Discussion
14.30 – 14.45	Summary of the Training

Day 1

Session 1: Inventory methods for GHG emissions from "Energy" sector

Section 1: Emission sources and greenhouse gases

Section comments:

GHG emission calculation method has two components:

- Calculating emissions from **fuel combustion**
- Calculating **methane emissions** from fossil fuel handling activities.

Each component is rather independent, with separate worksheets for data input and calculation procedures. Results of the two are merged at the final stage of inventory preparation when the summary tables for all gases in the country are prepared. This detail may be used to plan the inventory work: for example, the fuel combustion emissions may be calculated first (which in Ukraine account for approximately 98% of CO_2 emissions and 80% of total emissions in CO_2 equivalent in), and the methane emissions second.

Calculating emissions from fuel combustion

This component in its turn contains two parts:

1) CO_2 emissions (sections 1.2A and 1.2B discuss calculation approaches)

2) Non-CO_2, GHG emissions (section 1.3)

CO_2 emissions in energy sector are many times higher than those of other gases, therefore, section 1.3 provides only an estimate, which is basically the multiplication of fuel consumption data and appropriate emission factors.

Calculating methane emissions

This component also has two parts:

1) methane emissions from coal production and processing (section 1.5)

2) methane emissions from oil and gas related activities (section 1.6).

This accounts for both regular and emergency emissions, as well as those from equipment repair and maintenance.

Both components are equally important as for the total emissions. The absence of interdependence enables to plan consecutive calculations and measurements.

Section 2: CO_2 emissions and approaches in calculation

Section comments:

CO_2 emissions from fuel combustion is dominating GHG source in Ukraine, therefore it has to be considered in the most detail. Pursuant to international methodologies two approaches are suggested:

1) Calculating emissions on the basis of fuel combustion cumulative data on different fuel types - the *Reference approach*.

2) Calculating emissions *by sources*, which discusses fuel combustion in different sectors of economy (*bottom-up approach*).

In the case of Ukraine, it is recommended to address the following sectors:

- Power sector in its narrow sense of electric and heat energy production and supply
- Production of electric and heat energy by enterprises not belonging to the power sector
- Transportation: cars, aircraft, water transport, railroad and pipelines
- Residential sector, including the district heating and private housing
- Other sectors (depending on the regional economy structure).

Section 2: IPCC Reference approach

Section 3: Approach by emission sources

Sections 2 and 3 comments: The IPCC *Reference approach* is undoubtedly less complicated and requires less data than the approach *by sources*. The national data, available at State Committee for Statistics or Ministry of Fuel and Energy may suffice for the reference approach, while a separate data collection across the economy sectors might be necessary for the approach by emission sources. On the other hand, only the bottom-up approach can provide for the appropriate level of international joint projects (joint implementation) or participation in the emissions trading in any way.

In spite of the drawbacks of the reference approach, it must be used to give a full picture of total fuel burnt (the 'by sources" approach will not enable to take into account small consumers). The figure in the result of the bottom-up approach will always be somewhat smaller than the total volume of the fuel consumed. This is true for all countries, those possessing an excellent reporting system including.

Consequently, both approaches have to be used - one to have a general idea and the other one - for more details and planning GHG reduction measures.

Therefore it is recommended first to make a general estimate using the Reference approach and then calculate emissions by sources.

Section 4: Emissions from mobile sources

Section 5: Emissions from burning biomass

Section 6: GHG emissions in coal sector

Section comments:

Methane emissions in the coal sector occur at the stages of coal production, enrichment, transportation, and use. Methane is contained in coal layers. The deeper the mining beds are located, the higher is the pressure and the temperature, which defines the amount of methane stored during coalification. The amount of methane formed is also affected by gas flow capacities of the coal layers, which depends on the natural features of the rocks. There also exists a zone of natural ventilation (200-300 meters in average), within which methane is being released through natural wrecks. According to IPCC methodology the coal-bed methane emissions are calculated on the bases of the coal production and processing volume and its methane content. As a rule, the methane emissions from underground mining are greater than from the surface mining because of the extraction depth.

Section 7: GHG emissions from oil and gas sector

Section comments:

Methane emissions in the oil and gas sector occur from extraction, refining, transportation and consumption of oil, natural and fugitive gas, as well as from their combustion for energy production. It does not include emissions from the combustion of oil, gas, mineral oil and processed gas for businesses' own needs during oil and gas transportation. Such emissions are considered as those related to the useful fuel combustion; methods of their estimation are given in the previous sections of this module. This section covers emissions caused by burning of natural and fugitive gas in torches. Emissions from oil and gas systems include:

- Technological emissions, e.g. those connected with gas system expulsion, burning gas in torches during oil and gas production; regular releases or emissions through ventilation valves;
- Emissions from repairs and maintenance;
- Emissions from accidents.

Inventory Methods for GHG Emissions from the Energy Sector

Session 1

Emissions sources from "Energy" sector

I. FUEL COMBUSTOIN ACTIVITIES

- Heat and electric energy production
- industry
- transportation: auto, air, water, railroad, pipeline
- commercial/institutional
- residential
- agriculture/forestry
- other sectors
- biomass burned for energy production

II. FUGITIVE EMISSIONS

- coal mining
- oil and gas sector

Energy 2

Major greenhouse gases in the "energy" sector

Direct GHG:

- carbon dioxide - CO_2,
- methane - CH_4,
- nitrous oxide - N_2O

Indirect GHG:

- oxides of nitrogen (NO_x)
- non-methane volatile organic compounds (NMVOC)
- carbon monoxide (CO)

Energy 3

Carbon Dioxide Emissions

- When fuels are burned, most carbon in the fuel is emitted as CO 2 immediately during the combustion process.
- Some carbon is released as CO, CH 4 or non-methane hydrocarbons which oxidise to CO 2 in the atmosphere within a certain period of time.
- Some of the carbon remains unburned or partially oxidised as soot or ash (due to inefficiencies in the combustion process).
- Different fuel types have different carbon content per unit of useful energy:
  - Coal has the most carbon per unit of useful energy
  - Oil has about 80% the carbon of coal
  - Natural Gas has about 55% the carbon of coal

Energy 4

General equation for calculating CO_2 emissions from fossil fuel combustion

Actual CO_2 released across all fossil fuel types is calculated according to the following formula:

$$CO_2 = [(C_p - C_s) \times C_o] \times 44/12$$

where:

C_p = potential carbon releases

C_s = sequestered (stored) carbon

C_o = % of oxidized carbon

44/12 – molecular to atomic ratio of carbon in carbon dioxide

Energy 5

Two approaches to calculate CO_2 emissions

1. The IPCC Reference Approach or "Detailed Fuels Approach" or "Top-Down" Method.

Requires Information Only on the Quantities of Fuels Produced Indigenously, and Those Flowing Into and Out of the Country through Imports or Exports.

2. "Detailed Technology-Based Calculation" or "Bottom-Up" Method.

Requires a Substantial Amount of Information about National Energy Consumption Patterns in Each Sector of a Nation's Economy.

Energy 6

Types of Fuel

Liquid fossil fuel

- Primary: *crude oil, gas condensate*
- Secondary: *petroleum, kerosene, diesel fuel, mazut, liquefied gas, bitumen, lubricants, petroleum coke, other liquefied oil products*

Solid fossil fuel

- Primary: *anthracite, coking coal, bituminous, lignite, peat*
- Secondary: *coke, briquettes*

Gaseous fossil fuel

- Primary: *natural gas*

Energy 7

IPCC Reference Approach

Carbon accounting is based mainly on the total supply of primary fuels and the net quantities of secondary fuels brought into a country.

Step 1: Estimating consumption of fuels by fuel type (AP):

$$(AP) = P + I - E - IB - SC,$$

where P = production
I = imports
E = exports
IB = international bunkers
SC = stock change

(A Stock Build is Positive; A Stock Drawn is Negative)

Fuel consumption may be measured in tons of oil or coal equivalent, terra calories, terra joules, or other standard units.

Energy 8

IPCC Reference Approach (cont.)

Step 2: Convert the consumption data in original units into a common energy unit Conversion factors are based on the heat content of each fuel

- For example:
  - 10^6 tons of oil equivalent = 4.1868 * 10^4 TJ
  - 1 tera calorie = 4.1868 TJ
  - 1 TJ = 10^{12} J
- Other metric energy units:
  - 1 exa joule (ЭДж) = 10^6 TJ
  - 1 peta joule (ПДж) = 10^3 TJ
  - 1 giga joule (ГДж) = 10^{-3} TJ
  - 1 mega joule (МДж) = 10^{-6} TJ
  - 1 kilo joule = (КДж) = 10^{-9} TJ

Energy 9

IPCC Reference Approach (cont.)

Step 3: Selecting carbon emission factors for each fuel product type and estimating the total carbon content of the fuels

Total carbon content (C_p)

C Gg = Σ apparent energy consumption (by fuel type in TJ) * carbon emission factor (by fuel type in tons of C per TJ) * 10^3

Energy 10

IPCC Reference Approach (cont.)

Step 4:Estimating the Amount of Carbon Stored in Products for Long Periods of Time (example: plastics, nylon)

General formula is :

Total Carbon Stored (Gg C) = Non-Energy Use (10^3 t) x Conversion Factor (TJ/10^3 t) x Emission Factor (t C/TJ) x Fraction Carbon Stored x 10^3

Where Non-Energy uses of combustible include:Naphtha, lubricants, Bitumen, Coal Oils/Tars, Gas as Feedstock, Gas/Diesel Oil as Feedstock, LPG as Feedstock

Energy 11

IPCC Reference Approach (cont.)

Step 5: Accounting for Carbon Not Oxidised During Combustion

Carbon oxidized during combustion = $(C_p - C_s)^* C_o$

The Assumption for the Fraction of Carbon Oxidised is:

- Coal = 91- 98 %
- Oil and Oil Products = 99 %
- Gas = 99.5 %
- Peat for Power Generation = 99 %

Apply to Each Fuel Type and Sum Up for Total Carbon Emissions

Energy 12

IPCC Reference Approach (cont.)

Step 6: Converting Emissions as Carbon to Full Molecular Weight of CO 2

Total Carbon Dioxide Emitted from Fuel Combustion = Total Carbon Emissions (from Step 5) x the Molecular Weight Ratio of CO 2 to C (44/12)

- International bunkers Emissions are Calculated Separately with the use of the same Calculation Methodology and Excluded from National Totals

Energy 13

Detailed technology-based approach

- GHG emissions are assessed according to economic sector and/or type of technology used.
- Approach is conceptually similar to the Reference Approach.
- Countries should also apply the Reference Approach and attempt to compare the results.
- Method is applied for calculating CO2 and other GHG emissions from fuel combustion
- Countries are to determine the level of detail they want to apply to calculations

Energy 14

Detailed technology-based approach (cont.)

Emissions are calculated at least for the following sectors:

- Energy transformation
  - heat and electric energy
  - oil refineries
- Transportation
- Industry
- Agriculture
- Residential
- Commercial / Institutional

Energy 15

Detailed technology-based approach (cont.)

Steps in calculation

- **Step 1**: Estimate Fuel Consumption by Sector and Technology Type
- **Step 2**: Convert to a Common Energy Unit
- **Step 3**: Multiply by Appropriate Carbon Emission Factors to Compute Potential Emissions
- **Step 4**: Estimate the Amount of Carbon Stored in Products for Long Period of Time
- **Step 5**: Adjust for Unoxidised Carbon
- **Step 6**: Convert Emissions as Carbon to Full Molecular Weight of CO 2

Energy 16

Detailed technology-based approach (cont.)

Carbon Emissions = Fuel Consumption (actual rather than apparent) Expressed in Energy Units (TJ) x Carbon Emission Factor - Carbon Stored x Fraction Oxidised

Calculation of other GHG emissions from stationary sources:

$$\text{Emissions} = \Sigma(EF_{abc} \times \text{Activity}_{abc}),$$

where: ***EF*** = emission factor (kg/TJ),
Activity - energy input (TJ),
a - fuel type,
b - sector activity,
c - technology type.

Energy 17

Detailed technology-based approach (cont.)

Non-CO_2 emissions from stationary sources include:

- 2 Direct GHGs: CH 4 and N 2 O
- 3 Indirect GHGs: NO x , CO and NMVOCs

Energy 18

Detailed technology-based approach: major steps to estimate non-CO_2 emissions)

1. Determine Source and Form of Energy Activity Data
- best available sub-national, national and/or international data
2. Develop Emission Factor Data
- default values in Reference Manual are in need of improvement
- based on fuel type, technology, operating conditions, maintenance and vintage of technology
3. Identify the Technology Splits for Energy Data
- according to main technology type and the extent of pollution control

Energy 19

GHG emissions from mobile sources

- CO_2 emissions from mobile sources are calculated together with the other economy sectors
- Non-Co_2 emissions are due to incomplete combustion and other GHGs post-combustion controls
- Estimation of mobile sources emissions requires consideration of many parameters, including fuel type, vehicle type, pollution control equipment type.

Energy 20

GHG emissions from mobile sources: *parameters to determine emission factors*

- Transport class: *road, non-road*
- Fuel consumed: *gasoline, diesel, natural gas, liquefied gas, methol/ethanol*
- Pollution control: *Advanced 3-way and early 3-way,oxidation catalyst, moderate control, no control*
- Vehicle type: *cars, light vehicles, heavy-duty vehicles, motorcycles, ships/boats, locomotives, farm equipment, aircraft, etc.*

Energy 21

GHG emissions from mobile sources (cont.)

- **Basic calculation:**

$$\text{Emissions} = (EF_{abc} * FC_{abc}),$$

where,

EF - emission factor

FC - amount of energy consumed or distance traveled

a - fuel type (e.g. diesel, gas)

b - vehicle type (e.g. cars, HDV)

c - Emission control

Energy 22

GHG emissions from mobile sources: *steps to follow*

Step 1a: Determine amount of energy consumed (by fuel type and transport modes)

Step 1b: If distance traveled is activity measure, determine average distance traveled for each vehicle and fuel type

Step 2: Multiply amount of energy consumed, or distance traveled by each category of vehicle, by corresponding emission factor.

Step 3: Sum across all fuel categories and technology types

Energy 23

GHG emissions from mobile sources: *challenges and limitations*

- Emission Factors Rely Heavily on Experience Measurements in Industrialised Countries
- Data on Technology Splits and Level of Pollution Control is Not Readily Available
- Much of the Relevant Data May Exist, but is Not Easily Obtained

Energy 24

GHG emissions from burning biomass fuel

- Biomass fuel (e.g. wood, charcoal, bagasse) are used in variety applications, including residential, commercial and industrial
- Biomass combustion results in emission of all greenhouse gases
- Net CO_2 emission at "renewable" use is treated as zero
- CO_2 emission for land-use change are accounted in "Land-Use Change and Forestry" section

Energy 25

GHG emissions from burning biomass fuel (cont.)

Two steps of calculation:

Step 1

- carbon released from biomass = total biomass consumed * fraction oxidized * carbon fraction
- carbon released from charcoal production = (fuelwood used in charcoal production * fraction of fuelwood) - (charcoal produced * carbon fraction of charcoal)

Step 2

- Non-CO_2 emissions = carbon released * emission ratio * molecular weight ratio (R)
- R = CH_4 :16/12, N_2O : 44/28, NO_x : 46/14, CO : 28/12

Energy 26

Fugitive emissions (leaks) from coal mining and handling activities

- Fugitive emissions of methane (CH_4) occur from production, processing, handling and utilization of coal
  - emission level depends on coal rank and depth, gas content, mining method, etc.
- Other fugitive emissions include CO_2 from burning coal mines and waste piles and from SO_2 scrubbing

Energy 27

Fugitive emissions from coal production

Calculation levels:

Level 1: use of average common emission factors

Level 2: use of average emission factors for a country or a mining area

Level 3: individual calculation for mines or mine sections

Energy 28

Fugitive emissions from coal handling activities

- Major sources include underground mining, surface mining, processing, transportation and handling
- Methane emissions (Gg CH_4) = emission factor ($м^3$ CH_4 / ton) * coal production (tons) * conversion factor (Gg / 10^6 $м^3$) - methane captured (Gg)
- Emission factors reduce by activities: underground mining, surface mining, post-mining activities
- Conversion factor under 20°C and 1 atmosphere is 0.67 Gg / 10^6 $м^3$ CH_4)

Energy 29

CO 2 Emissions from Burning Coal Deposits and Waste Piles

The General Formula for Calculating is:

Emissions from Coal Burning (Gg C) = Quantity of Coal Burned (103t) x Emission Factor

Where: Emission Factor is:

Percentage of Carbon in Coal x Percentage of Carbon Oxidised; (and the default value is 50%)

CH_4, N_2O, CO and NO_x are among other GHG Emissions from Combustion of Coal Waste

Care should be taken to avoid double counting (in this section and "fuel combustion" section).

Energy 30

Methane emissions from oil and natural gas production, processing, transportation and handling

- Emissions from oil and gas sector include:
  - from regular system operation
  - from burning in torches and fugitive emissions
  - from repair and maintenance
  - emergency emissions
- Major activities resulting in emissions include:
  - oil and gas recovery
  - oil transportation
  - natural gas storage and processing
  - natural gas transportation and distribution

Energy 31

Methane emissions from oil and natural gas production, processing, transportation and handling

Calculation levels:

Level 1: use of average emission factors and aggregated statistical data on production, transportation and consumption

Level 2: oil and gas balance and emission factor calculation

Level 3: Use of local emission factors and calculation by segments of oil and gas industry

Energy 32

Methane emissions from oil and natural gas production, processing and transportation

- Level 1 calculation methodology
  - Data required: oil and gas production, oil refinery and transportation, gas processing, transportation and distribution in peta joules, PJ = 10^{15} J (A)
  - emission factor (EF, kg CH_4/PJ) (F)
  - Emissions = A * F
  - Emissions are summed across categories
- Emission factors are calculated for 5 regions: USA and Canada, former USSR countries and Eastern Europe, Western Europe, oil producing countries, the rest of the world

Energy 33

"Good practice" for GHG inventory

- According to the recent IPCC recommendations, a good GHG inventory:
  - uses detailed methods and data
  - includes emissions calculations up to the recent years
  - provides an estimate of calculation inaccuracy
  - provides detailed description of data and methods used
  - is based on detailed calculation quality verification

Energy 34

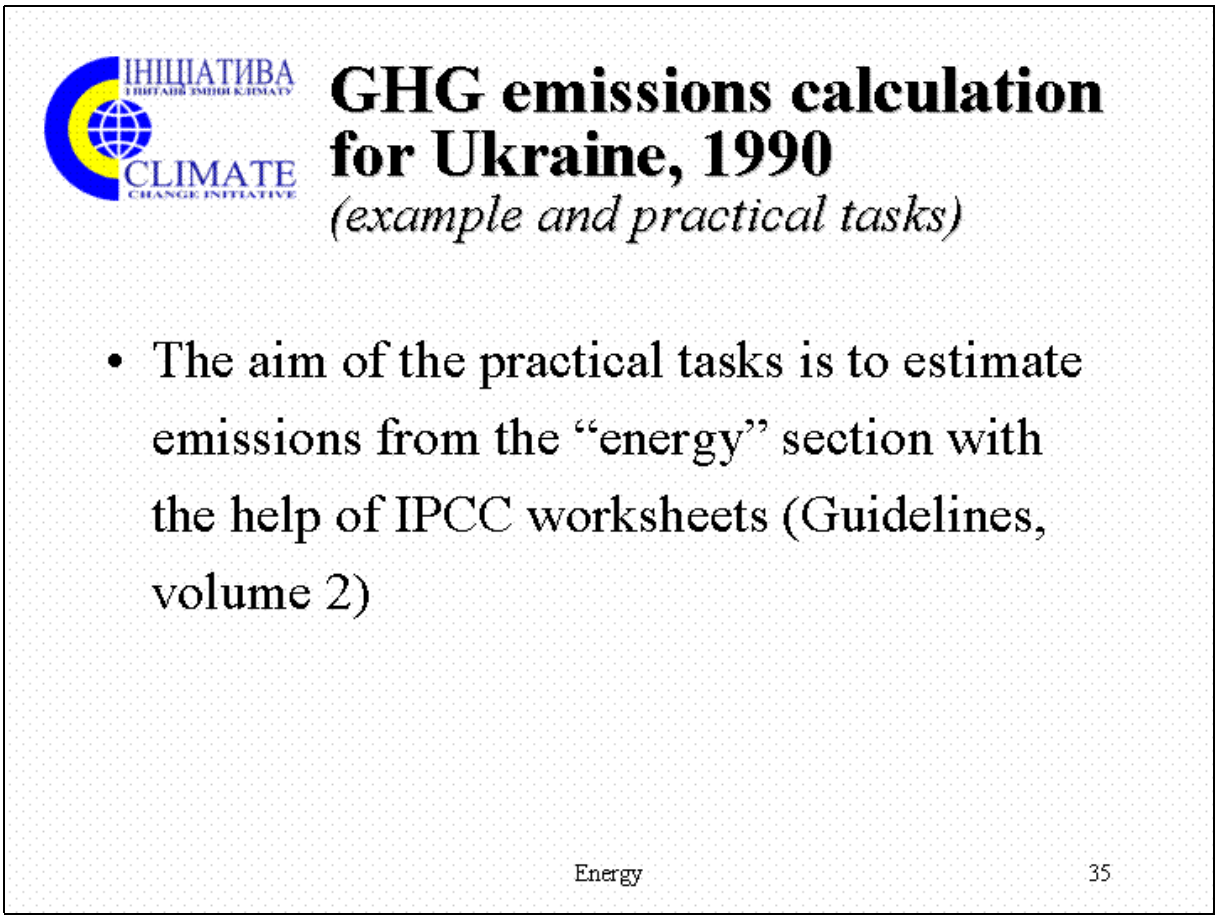
Day 1

Session: Basic methods of GHG emissions inventory

Calculation of GHG emissions on the example of Ukraine: group practical training

The practical exercise has to base on the regional specific fuel details.

Example of the potential assignment is available in Ukrainian language.



Day 2

Experience in preparing greenhouse gas inventory

The second day presentations contain information on the experience in preparing GHG inventory in Ukraine and abroad (mainly USA). This information has to be regularly updated. Examples of four courses mentioned below are available in Ukrainian with Session 5 available in English as well.

Session 2: Inventory of GHG emissions in USA

Session 3: Inventory of GHG emissions in Ukraine

Session 4: Inventory of GHG emissions in the power sector of Ukraine

Session 5: Inventory of GHG emissions in the coal sector of Ukraine

Process for Preparing Inventory of U.S.A. Greenhouse Gas Emissions

Inventory of Greenhouse Gas Emissions
in the Energy Sector
Session 2

Presentation Overview

- Gases and sources included
- Administrative structure for preparing U.S.A. greenhouse gas inventory
- Data management structure for U.S. greenhouse gas inventory
- Methodological approach
- Data Sources
- Estimating emissions from fossil fuel consumption

US Experience 2

Gases and Sources Included

- Emissions in the USA are estimated for the following gases:
  - CO_2
  - N_2O
  - CH_4
  - HFCs
  - PFCs
  - SF_6, as well as CO_2 buildup
- Carbon uptake from land use change and forestry

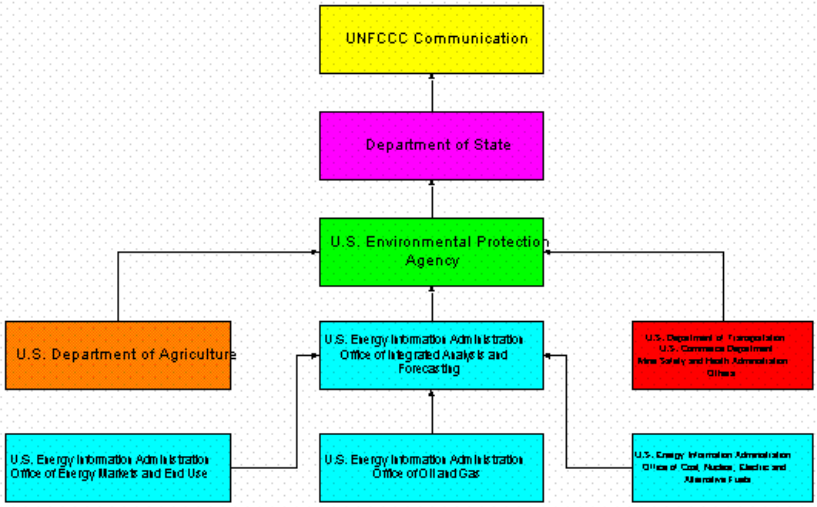
US Experience 3

Gases and Sources Included (cont.)

- GHG emissions sources estimated include:
  - power sector
  - industrial processes
  - solvents
  - agriculture
  - wastes
  - land use change and forestry

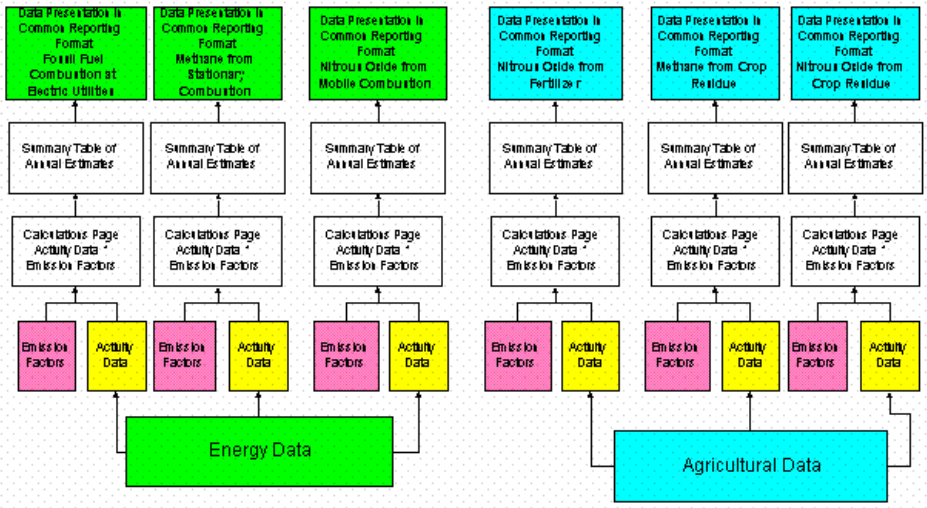
US Experience 4

U.S.A Administrative Structure for GHG Inventory - Overview



US Experience 5

Sample Data Management for GHG Estimates of Emissions from Energy and Agriculture



US Experience 6

Methodological Approach

- Activity data * Emission factor = Emissions
- IPCC "Good Practice" guidance used
- Use all three tiers of IPCC methodologies
- Bottom-up and top-down approach used in conjunction
- Data presented in common reporting format
- Formal quality control and quality assurance process

US Experience 7

Data Sources

- Power sector
  - Department of Energy, Energy Information Administration
  - Department of Transportation
  - Mine Safety and Health Administration
  - American Gas Association
  - American Petroleum Institute

US Experience 8

Data Sources (continued)

- Agriculture
  - U.S. Department of Agriculture
- Solvents
  - U.S. Environmental Protection Agency
- Wastes
  - U.S. Environmental Protection Agency
- Land use and forestry
  - U.S. Forest Service

US Experience 9

Estimating Emissions From Fossil Fuel Consumption

- More than 80 percent of U.S.A greenhouse gas emissions are from fossil fuel consumption
  - Transport = 33%
  - Industrial = 32%
  - Residential = 19 %
  - Commercial = 16 %
  - Electricity-related emissions (37% of total) are distributed across end use sectors
- Emissions reduced by:
  - non-fuel use
  - international bunker fuels

US Experience 10

Estimating Emissions from Fossil Fuels: Data Collection

- Coal consumption from electric utilities
  - All utilities report consumption to Energy Information Administration (EIA)
- Petroleum products supplied
  - All refineries (153) report totals of 20 separate petroleum products supplied to EIA
- Natural gas supplied
  - All producers and suppliers are required to report to EIA
  - About 7% of gas consumption "missing"

US Experience 11

Estimating Emissions from Fossil Fuels: Data Collection (cont.)

- Industrial energy consumption
  - Estimated from sample survey of 22,000 of 239,000 enterprises conducted by EIA
  - Survey conducted every four years
- Residential energy consumption
  - Estimated from sample survey of 7,000 of 100 million U.S.A homes
  - Survey conducted every 3 years

US Experience 12

USA Inventory Preparation Schedule

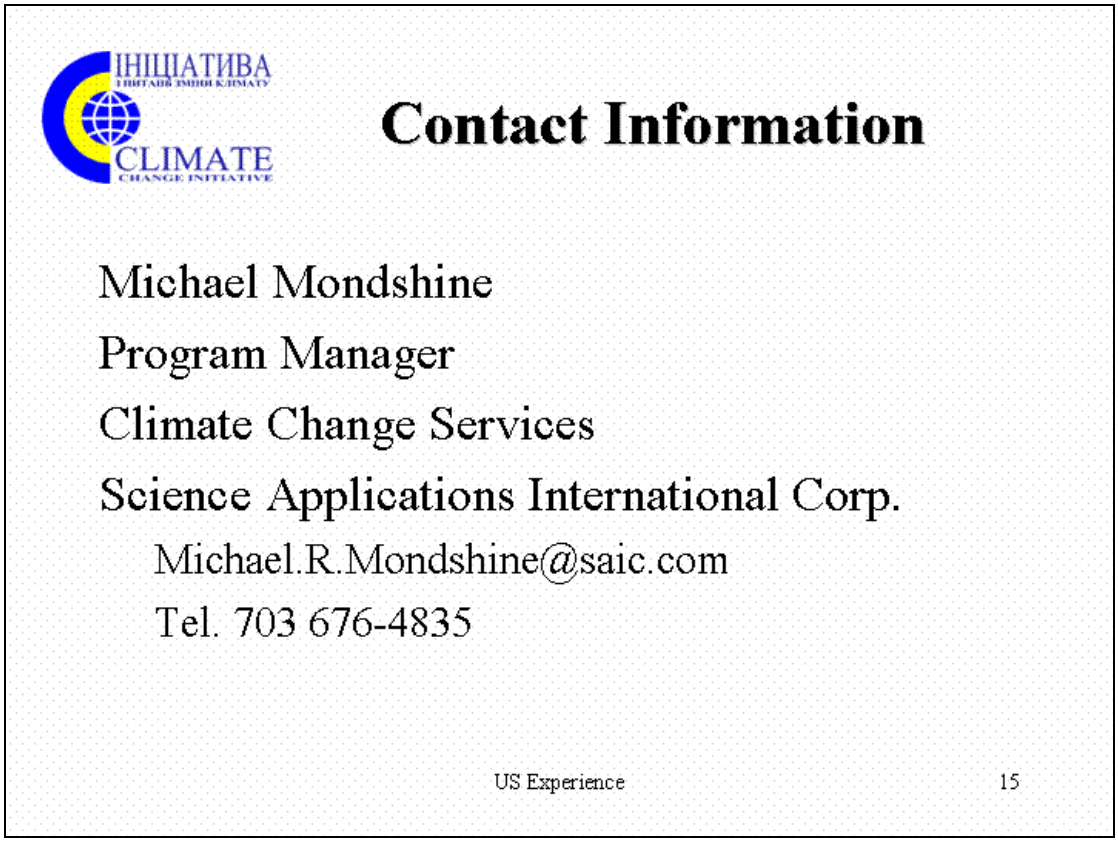
- Draft estimate of emissions - 15/9/01
- Experts review - 30/10/01
- Public review begins - 30/11/01
- Submission to UNFCCC - 15/4/02

US Experience 13

Summary

- UNFCCC Inventory Review Team described U.S.A inventory as "state-of-the-art"
- Final USA Inventory www.epa.gov/globalwarming/emissions/national

US Experience 14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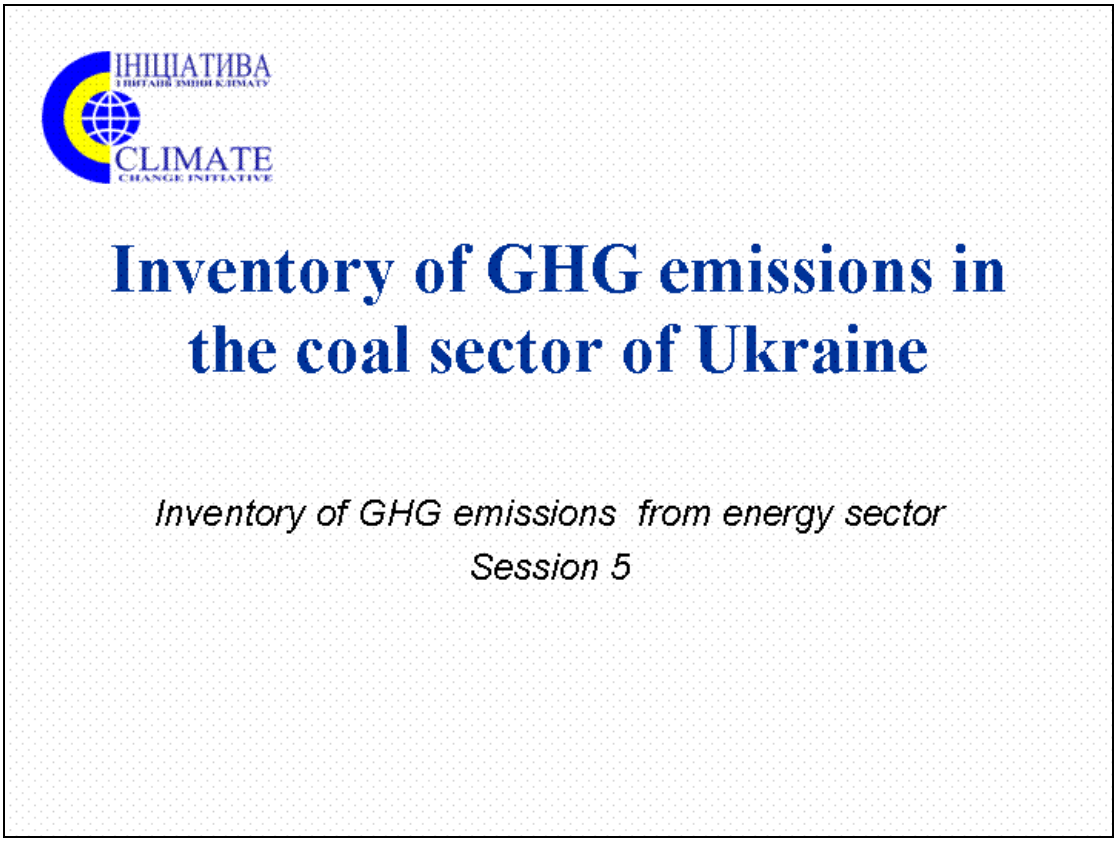
US Experience
15

Day 2

Experience in preparing greenhouse gas inventory

Session 3: Inventory of GHG emissions in Ukraine



US EPA CBM Outreach Program in Ukraine:

Исполнитель: Партнеры по Экономической Реформе
Implementor (grantee): Partners in Economic Reform, Inc.

Украинские партнеры:

- Министерство экологии и природных ресурсов
- Центр альтернативных видов топлива

Ukrainian Partners:

- Ministry of ecology and natural resources
- Alternative Fuels Center

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US EPA CBM Outreach Program in Ukraine:

Главная цель программы:

Main objective:

Способствовать освоению ресурсов метана угольных месторождений в Украине

Facilitate Ukrainian coal bed methane resources exploration through:

- экологическая оценка влияния выбросов метана из угольных шахт
- *environmental assessment of coal mine methane emissions*
- информационная поддержка инвестиционных проектов
- *information support of CBM/CMM projects*

3

US EPA CBM Outreach Program in Ukraine:

Работы в рамках программы: **Program Activities:**

- Инвентаризация эмиссий шахтного метана в Украине
- *CMM emissions inventory for Ukraine*
- Публикация справочника о газовых шахтах Украины, наиболее привлекательных для инвестиционных метановых проектов
- *Development of the handbook about Ukrainian mines most attractive for CMM projects development*
- Подготовка бизнес-планов для проектов по разработке и утилизации метана на шахтах Донбасса
- *Development of business plans for two mines*
- Распространение этих документов для привлечения потенциальных иностранных инвесторов к реализации метановых проектов
- *Dissemination of these materials among potential investors*

4

Ukrainian Inventory of coal mine methane emissions (1990-1999):

- **US EPA выделило грант для проведения инвентаризации метана на уровне отдельных шахт по всей Украине за период 1990 - 1999 г. Это первая попытка провести инвентаризацию эмиссий на уровне отдельных предприятий в целом по стране.**

US EPA gave a grant to develop a mine-specific CMM emissions inventory of Ukraine for 1990-1999. This is the first attempt to develop a site-specific GHG inventory in Ukraine.

- **В предыдущих кадастрах парниковых газов эмиссии шахтного метана были подсчитаны на основании методологии, рекомендованной РКИК. Общее производство угля умножалось на коэффициенты эмиссии для соответствующих регионов.**

Previous Ukrainian inventories accounted for CMM emissions based on calculations under the IPCC guidelines. I.e. the total emissions were obtained multiplying the coal production by basin-specific emissions factors

- **В настоящем кадастре более 85% данных - статистические данные, предоставленные шахтами.**

The current inventory consists of more than 85% actual measurement data

5

Ukrainian Inventory of coal mine methane emissions (1990-1999):

Источники данных для кадастра эмиссий шахтного метана:

Data sources for CMM emissions inventory

- Департамент Угольной промышленности Министерства топлива и энергетики Украины; *Department of coal industry of the Ministry of fuel and energy of Ukraine*
- Министерство экологии природных ресурсов Украины; *Ministry of ecology and natural resources of Ukraine*
- Государственный Комитет по охране труда Украины; *State Committee for Labor Safety of Ukraine*
- Макеевский НИИ по безопасности работ в горной промышленности (МакНИИ); *Makeyevka mine safety institute*
- Центр альтернативных видов топлива; *Alternative Fuels Center*
- Угольные Государственные холдинговые компании; *Coal Associations*
- отдельные шахты; *Individual mines*
- данные украинских экспертов *Ukrainian experts' data*

6

Ukrainian Inventory of coal mine methane emissions (1990-1999):

В кадастре эмиссий шахтного метана (1990 - 1999) ассмотрены следующие категории эмиссий в Донецком и Львовско-Волынском угольных бассейнах Украины:

The following categories of emission sources were considered for Donetsk and Lviv-Volyn coal basins of Ukraine:

- эмиссии метана при подземной добыче угля; *emissions from underground coal production*
- эмиссии метана при добыче угля открытым способом; *emissions from surface coal production*
- эмиссии метана при последующей деятельности; *emissions from postmining activity*
- обьемы извлеченного и использованного метана. *recovered and utilized methane*

7

Ukrainian Inventory of coal mine methane emissions (1990-1999):

Методология учета эмиссий шахтного метана:

CMM emissions inventory methodology:

Общая эмиссия (годовая)=

эмиссия метана при подземной добыче угля

+ эмиссия метана при добыче угля открытым способом

+ эмиссия метана при последующей деятельности

- объемы извлеченного и использованного метана.

Total emission =

emissions from underground mining

+emissions from surface mining

+emissions from postmining activity

- recovered and utilized methane

* В кадастре учтены только эмисии метана при добыче угля на действующих угольных шахтах Украины

Only emissions from active mines were considered

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Ukrainian Inventory of coal mine methane emissions (1990-1999):

Методология учета эмиссий шахтного метана:

- Эмиссия метана при подземной добыче угля: *Underground coal production:*

  статистические данные по эмиссии из систем вентиляции и дегазации, полученные от шахт;

  actual measurements from degasification and ventilation systems;

- Эмиссия метана при добыче угля открытым способом: *Surface mining:*

  объем добычи угля х коэффициент эмиссий (по бассейнам)

  coal production X basin-specific emissions factor

- Эмиссия метана при последующей деятельности (транспортировка, обогащение, использование угля): *Postmining activity:*

  объем добычи угля х коэффициент эмиссий (по бассейнам)

  coal production X basin-specific emissions factor

- Объемы извлеченного и использованного метана:

  статистические данные, полученные от шахт

  actual mine-specific data from the mines

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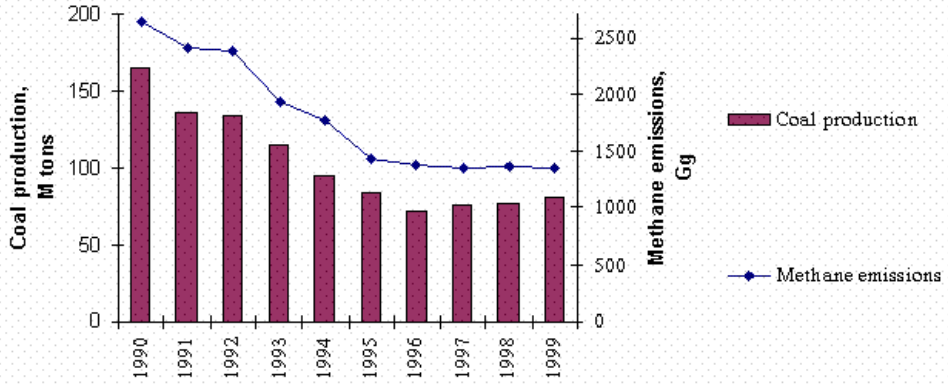
Ukrainian Inventory of coal mine methane emissions (1990-1999):



Coal production and CMM emissions in Ukraine in 1990-1999.

10

Ukrainian Inventory of coal mine methane emissions (1990-1999):

За период 1990 - 1999 г. в Украине:

During 1990-1999 in Ukraine

- добыча угля сократилась с 165 млн.тонн до 80 млн. тонн

coal production reduced from 165 million tonnes to 80 Mt

- количество шахт сократилось с 284 до 244

number of mines reduced from 284 to 244

- эмиссии метана сократились с 2,637.92 Gg до 1,345.51 Gg

methane emissions reduced from 2,637.92 Gg to 1,345.51 Gg

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Ukrainian Inventory of coal mine methane emissions (1990-1999):

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Высвобождено (подземная добыча угля) Liberated underground	2,518.04	2,321.96	2,209.90	1,825.93	1,706.43	1,383.74	1,312.60	1,289.41	1,316.86	1,290.89
Утилизировано (подземная добыча угля) Utilized	98.46	93.84	Н/Д	47.19	64.54	60.55	32.69	38.59	56.63	53.68
Общая эмиссия (подземная добыча угля) Total emitted underground	2,419.58	2,228.12	2,209.90	1,778.74	1,641.89	1,323.19	1,279.91	1,250.82	1,260.23	1,237.21
Эмиссия при добыче открытым способом Emitted, surface	8.70	6.74	5.42	3.89	2.50	2.15	1.49	1.34	1.31	1.11
Эмиссия при последующей деятельности (для подземной добычи) Postmining underground	208.40	172.12	171.27	149.55	122.99	108.96	93.90	99.79	100.19	107.03
Эмиссия при последующей деятельности (для открытой добычи) Emissions Surface	1.24	0.96	0.77	0.56	0.36	0.31	0.21	0.19	0.19	0.16
Общая эмиссия TOTAL EMISSIONS	**2,637.92**	**2,407.94**	**2,387.36**	**1,932.74**	**1,767.74**	**1,434.61**	**1,375.51**	**1,352.14**	**1,361.92**	**1,345.51**

Результаты инвентаризации эмиссии шахтного метана в Украине (Gg) за период 1990 – 1999. Ukrainian CMM emissions inventory results (1990-1999)

12

Ukrainian Inventory of coal mine methane emissions (1990-1999):

Характерные показатели и результаты инвентаризации:

Some indicators and results of the inventory:

- В Украине 98% эмиссий шахтного метана приходится на подземную добычу угля;

98% of CMM emissions in Ukraine come from underground mining

- Основная часть метана выбрасывается в атмосферу:

Most of methane is emitted to the atmosphere

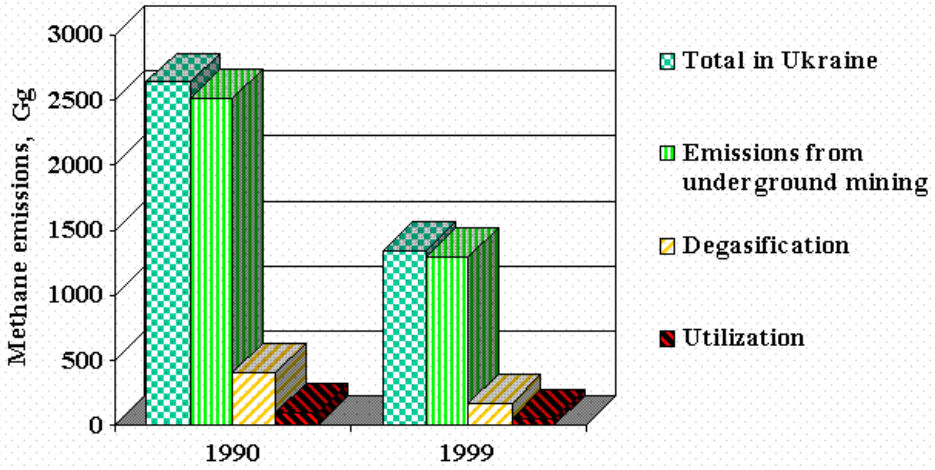
  - высвобождено в 1999 г. при подземной добыче 1,290.89 Gg
  - *total liberated methane underground 1,290.89 Gg in 1990*
  - каптировано в 1999 г. 174.31 Gg (13% от высвобожденного)
  - *captured 13% of total liberated methane in 1999*
  - утилизировано в 1999 г. 53.68 Gg (30% от каптированного)
  - *utilized 30% of captured methane in 1999*

- Данные инвентаризации отличаются от ранее полученных расчетным путем и представленных в предыдущих Национальных сообщениях на 5 - 8%

Current inventory results differ from previous National communications by 5-8%

13

Ukrainian Inventory of coal mine methane emissions (1990-1999):



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Methane recovery and utilization in Ukraine

В настоящее время реально шахтный метан используется следующим образом:

Currently there are following examples of CMM utilization in Ukraine:

- Шахтные котельные - перевод с угля на газ:

Mine boilers - switch from coal to gas

  - 8 шахт Донбасса используют метан для собственных нужд
  - *8 Donbass mines use CMM for self needs*

- Моторное топливо

Motor fuel

  - 3 автозаправочные станции (шахта им.Засядько, НПП Донугледегазация»)
  - *3 car gas-filling stations*

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Suggested Readings

IPCC guidelines on national inventory preparation. Joint IPCC/OECD program . Volume 1: Reporting instructions for GHG inventory. Volume 2: Workbook of the GHG inventory .

IPCC (Intergovernmental Panel on Climate Change) (1997), *IPCC Guidelines for National Greenhouse Gas Inventories,* 3 volumes: Vol. 1, Reporting Instructions; Vol. 2, Workbook; Vol. 3, Reference Manual. Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency. Paris, France.

Carbon Dioxide Information Analysis Center. Website. http://cdiac.esd.ornl.gov

Marland, G., and Rotty, R. (1984) Carbon dioxide emissions from fossil fuels: a procedure for estimation and results for 1950-1982. Tellus, 36b, 232-261.

United Nations Framework Convention on Climate Change.Website.http://www.unfccc.de/

Evaluation Form

Title of Module: Inventory for GHG emissions from the "Energy" sector

Date: **Module 4**

For each statement below, mark the circle on the scale that corresponds to your opinion.

		Evaluation Score					
		1	2	3	4	5	
1. The presentation of the module was	Unclear	O	O	O	O	O	Clear
2. The objectives of the module were	Not important	O	O	O	O	O	Important
3. The information presented at the module was	Not sufficient	O	O	O	O	O	Sufficient
4. The information presented at the module was	Not useful	O	O	O	O	O	Useful
5. The knowledge acquired through this module was	Insignificant	O	O	O	O	O	Important
6. Participating in this module enabled you to learn	Nothing new	O	O	O	O	O	Many new things
7. The exercises in this module were	Not interesting	O	O	O	O	O	Interesting

What did you like most about this module?

_____

_____

_____

What did you like least about this module?

_____

_____

_____

What is your opinion on presenters?

_____

_____

What is your opinion on organization of the module?

On what themes presented in the module would you like to get more information?

What module themes would be interesting for you in the future?

Comments:

Thank you for filling in the evaluation form.